REMARKS

Claims 1-13, 17, and 19-47 are all the claims pending in the application. By this Amendment, Applicants herein amend claims 1, 2, and 17 and add new claims 19-47. In addition, Applicants cancel claims 14-16 and 18.

Claim 1 has been amended to further clarify the invention. Claim 2 has been amended solely to conform to the new claim 1 while claim 17 has been rewritten in the independent form including all of the limitations of the base claim. Claims 19-47 have been added to clarify the subject matter claimed in the cancelled claims.

Claims 19-27 are dependent upon claim 1 and are clearly supported throughout the specification. Claims 19-24 find support, e.g., at pages 14-20 and FIG. 8; claims 25-26 find support, e.g., at pages 20-24 and FIG. 12; claim 27 finds support, e.g., at page 24, 28-29 of the specification. Claims 28-37 are device-readable medium and claims 38-47 are apparatus claims that correspond to the subject matter in claims 1 and 19-27.

Preliminary Matters

Applicants thank the Examiner for initialing the references listed on PTO/SB/08 A & B filed with the Information Disclosure Statement on May 6, 2004. Applicants also thank the Examiner for accepting the drawings filed on May 6, 2004.

Summary of the Interview

Applicants, in particular, thank the Examiner for the courteous in person interview on October 5, 2004. The PTO-413 requires Applicant to file a Statement of Substance of the

Interview. Applicants submit the following Statement of Substance of the Interview, pursuant to PTO-413:

During the Interview, claims 1, 14, and 16 were discussed. The Examiner has indicated that the claim 1 is unclear. Specifically, the Examiner has indicated that generation of the witness graphs and determining a conclusive result as recited in the original claim 1 is unclear and should be further specified. Therefore, in order to resolve the ambiguities noted by the Examiner, Applicant amends claim 1 to further clarify the invention.

Section 112 Rejection

The Examiner rejected the language in the original claims on various grounds under Section 112. Applicants have modified the language in claim 1 and have rewritten the subject matter in the other claims in the form of new claims 19-47. Applicants respectfully submit that the new claim language addresses any concerns by the Examiner with respect to Section 112. In view of the above, Applicants respectfully request the Examiner to withdraw this Section 112 Rejection.

Section 102(b) and Section 103 Rejections

The Examiner has rejected original claims 1, 15, and 16 as being anticipated under Section 102(b) by the technical paper D. Geist et al., "Coverage-Directed Test Generation Using Symbolic Techniques," in Proceedings of the International Conference on Formal Methods in CAD, pp. 143-58 (Nov. 1996) (herein referred to as the "Geist" reference). The Examiner has also rejected claim 1 as unpatentable under Section 103(a) over an article by Gupta et al. in view of the Geist reference. Applicants respectfully traverses these rejections in view of the following comments.

The Geist reference, in fact, discloses no more than what has already been identified as prior art in the specification. Geist is similarly directed to using formal verification techniques in combination with simulation. Geist discloses abstracting a design description into an abstract model, in the form of a finite state machine (FSM) representation. The FSM model is "translated" by "manually isolating the core design and removing parts of the design that are not relevant" to the design's functional properties. See Geist at p. 145-46. Then, the FSM model is then used to generate the simulation test vectors in a manner that optimizes the "coverage" of the design. See Geist at p. 143, 146-147.

As discussed in the specification, the general idea of using formal verification techniques in combination with simulation is known in the prior art (see Specification at p. 6, 10). In particular, the specification explicitly concedes that the prior art does disclose abstracting "an abstract model ... from a design description for generating simulation vectors" (Specification at p. 10, lines 6-9) as disclosed in Geist. In other words, with reference to FIG. 4 in the instant specification, Geist discloses the top half of FIG. 4 where an "abstract model" (Geist's FSM model) is generated using various manual and automatic abstraction techniques. As discussed in the Specification at pages 13-14, this "initial abstract model" can be constructed by focusing on the relevant datapath operations and using "cone-of-influence abstraction" to remove "any part of the design that does not affect the property" (Specification at page 13). This corresponds to the discussion in Geist where the FSM model is constructed by abstracting the design functionality and "removing parts of the design that are not relevant." Geist at p. 146.

In Geist and the prior art, however, it is this "abstract model" (namely the FSM model) that is then used to generate the simulation vectors for the simulation. This is not the case in the present invention as set forth in claim 1.

Rather, in the present invention as claimed in independent claim 1, the "abstract model" is then used in a "deterministic analysis" for "generating a witness graph for ... one or more correctness properties". It is then this "witness graph" which is used to automatically generate a testbench for simulation. An exemplary, non-limiting embodiment of this feature is illustrated by the lower part of FIG. 4 where the "abstract model" is further modified. With respect to this exemplary, non-limiting embodiment, the specification also explicitly points out that:

> [t]his work is broadly related to other works which have used formal verification techniques along with simulation for functional validation. In particular, an abstract model is abstracted from the design description for generating simulation vectors [as disclosed in the prior art references cited]. However, this model is further modified depending on the correctness property of interest and focus on automatic generation of the testbench, not just the simulation vectors.

Specification at p. 10.

In other words, Geist and the prior art does not disclose any of the ideas underlying the rest of FIG. 4, where a deterministic analysis is used to generate what the inventors refer to as a "witness graph"—which is a concept different from the "abstract model" disclosed in the prior art and in Geist. As recited in the specification, the "witness graph" term is "used to denote the collection of states and transitions in the design which are useful for enumerating witnesses or counter-examples for the required property." Specification at p. 9, lines 13-15. This is

accomplished by applying deterministic methods such as symbolic model checking or constraint solving to "precompute a set of abstract states which are likely to be part of witnesses, and to use this set for guidance during simulation over [the concrete design], in order to demonstrate a concrete witness." Specification at p. 15, lines 11-13. The "witness graph" is a "graph" as that term is understood in the art and, as such, is distinguishable from an approach like Geist that relies on execution "paths" in the abstract model. Analyzing the paths in the abstract model is not sufficient for handling general CTL properties (such as branching time properties, which require the alternation of A and E quantifiers in CTL). Accordingly, a prior art approach like Geist can only handle linear time properties (with no alternation between A and E quantifiers) and only describes those properties that assert "coverage" of some transition along with satisfaction of certain constraints along the "path".

Additional exemplary embodiments further highlight the differences between the present invention notion of a "witness graph" and the prior art notion of an "abstract model". For example, an embodiment is disclosed where this deterministic analysis is iterated, as discussed in the specification:

> Recall that the initial abstract model was obtained by abstracting away many of the datapath variables as pseudo-primary inputs. Refinement is performed by selectively bringing back some of these datapath variables into the state space of the abstract model. Note that pruning after analysis reduces the size of the model, while refinement increases it. This iterative increase/decrease in the model size is shown in Fig. 12.

Specification at p. 12, lines 2-7. Thus, the "witness graph" can expand or contract within the context of focusing on those states that can serve as witness/counter-examples during the analysis. In stark contrast to the inventors' notion of a witness graph which captures all states and transitions in the abstract model which are useful for enumerating witness or counterexamples in the full design, the Geist approach is to generate only a single trace at a time on the abstract model—which is then concretized later for generating a simulation vector for the full design. The inventors' solution, in essence, side-steps the problem of concretization by pushing it into the search during simulation on the full design.

The Gupta article does not cure the deficient teachings of Geist in that it similarly fails to disclose generating a witness graph as set forth in claim 1.

Therefore, "generating a witness graph for said one or more correctness properties based on a deterministic analysis of said abstract model where the deterministic analysis serves to modify the abstract model by over-approximating states and transitions which capture all witnesses or counterexamples demonstrating said one or more correctness properties; and where the deterministic analysis does not produce a conclusive result, generating a testbench automatically from said witness graph," as set forth in claim 1 is not taught or suggested by Geist, or the combined teachings of Gupta and Geist, which lack generating a witness graph. For at least these exemplary reasons, Applicants respectfully submits that claim 1 is patentably distinguishable from Geist and is patentable over the combined teachings of Gupta and Geist. Therefore, Applicants respectfully request the Examiner to withdraw this rejection of claim 1. Claims 2-13 are patentable at least by virtue of their dependency on claim 1.

Allowable Subject Matter

Applicants thank the Examiner for indicating that claim 17 contains allowable subject matter and would be allowed if rewritten in independent form including all of the limitations of the base claim. Applicants herein so rewrite claim 17 into independent form.

New Claims

New claims 19-27 are patentable at least by virtue of their dependency on claim 1. New independent claims 28 and 38 recite analogous features to the ones argued above with respect to claim 1. Therefore, claims 28 and 38 are patentable for at least substantially the same reasons. Claims 29-37 and 39-47 are patentable at least by virtue of their dependency on claims 28 and 38, respectively.

Conclusion

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly invited to contact the undersigned attorney at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

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